**CHEM 294: Introduction to Chemical Research**

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| **Course Name:** | CHEM 294: Introduction to Chemical Research, 2 credits |
| **Prerequisites:** | CHEM 212 or CHEM 321 or instructor permission |
| **Lecture/ Lab:** | Monday 2:15-6:15, REIC 138 |
| **Final exam:** | Tuesday, May 3 at 3:15-5:15pm |


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| **Instructor:** | Dr. Sarah Hayes |
| **Office:** | Reichardt 188 |
| **Phone:** | 907-474-7118 |
| **Email:** | s.hayes @alaska.edu |
| **Office Hours:** | TBD, By appointment, or drop by when my door is open |


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| **Blackboard Link:** | http://classes.uaf.edu |
| **Course website:** | http://chemresearch.community.uaf.edu |
| **Required materials:** | On Being A Scientist: A Guide to Responsible Conduct in Research, 3rd ed. The National Academies Press: Washington DC. ISBN: 978-0-309-11970-2 |

**Catalogue Course Description:** Scientific research is creative and engaging when properly planned and executed. This course introduces students to the process of planning and executing a research project. We will begin with an idea, review primary literature, brainstorm project ideas, pose a testable hypothesis, plan experiments, and execute a small research project.
Pre-requisites: CHEM 212 or CHEM 321

**Expanded Course Description:** In this course, mid-level chemistry majors are paired with graduate student mentors (enrolled in CHEM 694: Chemical Research Mentoring) based on research interests and be introduced to the process of planning a research project. Students in this course will begin with an idea, then review primary literature to survey ongoing research in that field, brainstorm project ideas, pose a testable hypothesis, then plan an experiment and execute a small research project. The emphasis of this course is to increase research readiness for students entering CHEM 488 by focusing on the research planning skills, although students will also have supervised hands-on lab experience. Join us to experience first hand how creative and engaging scientific research can be!

**Instructional Methods:** Undergraduate students will be paired with graduate student mentors enrolled in CHEM 694 Research Mentoring to develop and execute a research project. The emphasis of this course is on planning a research project through mentoring interactions with graduate students and faculty. Lectures will provide information on topics relevant to project planning while the actual planning and execution will occur during lab time.

**Course Goals:** Students will learn and practice the process of crafting an idea into a testable hypothesis and planning a research project to address their hypothesis. At the conclusion of this course, students will present their research plan and the results of preliminary investigations in a final presentation as well as have a research proposal to potentially submit for funding to continue their project.

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**Student Learning Outcomes:** Students will be prepared to plan and execute their future research projects. Upon successful completion of this course, students will:

- Complete all required safety trainings to work in labs in the UAF chemistry department.
- Propose an area of research, perform a literature review, and pose a testable hypothesis.
- Develop a realistic, statistically valid research plan.
- Execute preliminary experiments to provide preliminary data or proof of concept.
- Identify appropriate funding sources and write a proposal.

**Example Student Projects:** Student project topics will vary based on the expertise of graduate students enrolled in CHEM 694 and vary each semester.

- Investigation of toxic metals present in mine tailings as a function of particle size, which affects transportability, solubility, and bioaccessibility. This would involve drying soils, size separation using sieves and settling rate in water. Each size fraction could then be analyzed for elemental composition using bulk X-ray Fluorescence by preparing a pressed pellet.
- Investigation of chemical moieties present in size fractionated aerosol particulate samples by acid digestion and subsequent analysis by Inductively Coupled Plasma- Mass Spectrometry. Determining the size fractions metals are associated with is a critical component of determining the distance traveled by particulate matter.

**Course Evaluation:**

There are **500 total points available** in this class. Grades are assigned as follows: 500-450 A, 450-400 B, 400-350 C, etc.

| **Assignment** | **Points** |
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| Lab rotation summaries | 20 |
| Proposal format, proposal topic | 30 |
| Annotated Bibliography | 75 |
| Literature Review | 50 |
| Project Plan and revisions | 75 |
| Research proposal | 100 |
| Final presentation | 50 |
| Final research proposal | 50 |
| Mentor and instructor evaluations | 50 |
| **Total** | **500** |

Safety training- Students will perform all safety trainings required by the Department of Chemistry. This will be done through an in-person training January 26 2:15-5:15 pm in REIC 245.

Lab rotation summaries- Undergraduate students will participate in shadowing opportunities with graduate students. The students will then write a summary of their experiences.

***Students will progressively work toward developing a research proposal. Assignments will include:***

Research topic: 1-2 paragraph summary of the direction students are interested in pursuing.

Annotated bibliography: Summary of articles read related to your area of interest. Include properly formatted citations and references.

Literature review: 2-3 page summary of pertinent literature with appropriately formatted citations. This should be written to both report breadth of research in the area as well as the findings of a few of the most relevant studies. The last paragraph will clearly identify the need for the project idea previously proposed and refined through feedback from faculty and CHEM 694 mentors.

Project plan: The student will propose a specific plan for preliminary experiments as well as larger-scale potential follow-on experiments with a clear link to the testable hypothesis proposed. Required components: purpose, step-by-step instructions for performing preliminary lab experiments, safety plan, plan for statistical analysis of data, expected outcomes and how the results will be related back to the hypothesis, and potential large-scale follow-on experiments.

Research Proposal: Students will generate and revise an original research proposal with preliminary data that can be submitted for funding to continue the research project. The format and length of the proposal depends on where the proposal will be submitted.

Final presentation: Students will present a 10-minute presentation of their research proposal and the preliminary results during the final exam period.

Mentor and instructor evaluation: Students will have periodic feedback on their progress in their research progress with their mentor and instructor.

**Course Policies:** Continued attendance to class indicates each student agrees to the policies set forth in this syllabus.

Collaboration, Classroom Behavior and Late work- Collaboration and working in small groups is a key component of classroom and lab time. Your mentor is there to support your learning, not do the work for you. Students are expected to conduct themselves in a professional manner at all times. Disrespect of the classroom learning environment, instructors or mentors, and fellow students will not be tolerated!

Late work is accepted at a 20% per day reduction of the points possible. This is in an effort to keep the entire class moving though the projects efficiently.

Instructor-Initiated Withdrawals- Any time up to and including Friday, March 25, the instructor has the right to withdraw a student that "...has not participated substantially in the course." In CHEM 294 nonparticipation includes: poor attendance or lack of participation in lecture or lab (has missed more than 3 class sessions), or fails to turn in any assignment within a week of the due date.

Honor code and Academic integrity- Students are expected to conduct themselves in accordance with the UAF Honor code. The Chemistry Department policy states: *Any student caught cheating will be assigned a course grade of F. The students' academic advisor will be notified of this failing grade and the student will not be allowed to drop the course.*

Disability Services- I will work with the Office of Disabilities Services (208 Whitaker Bldg, 474-5655) to provide reasonable accommodation to students with disabilities. It is the student's responsibility to make an appointment with me to discuss appropriate accommodations within the first two weeks of the first class meeting. A letter from disabilities services must be provided for discussion at that time.

Veteran Support Services- Walter Crary (wecrary@alaska.edu)is the Veterans Service Officer at the Veterans Resource Center (111 Eielson Building, 474-2475). Fairbanks Vet Center 456-4238. VA Community Based Outpatient Clinic at Ft. Wainwright is 361-6370.

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**Tentative Schedule**

| Date | Week | Task(s) | |
|---|---|---|---|
| | | **Lecture (M 2:15-3:15)** | **Lab (M 3:15-6:15)** |
| Jan 25 | 1 | Introduction and course details | Class and mentor research introductions<br>**294: Undergraduate Experience Poll** |
| Feb 1 | 2 | Introduction to the research process<br>**694: Lab rotations plan** | 294: Safety training<br>694: Mentoring training |
| Feb 8 | 3 | Project funding | Lab rotations 1 |
| Feb 15 | 4 | Ethics & Keeping records<br>**294: ID funding target & template**<br>**694: Bring notebooks as example** | Lab rotations 2<br>**294: Mentor preferences**<br>**694: Bring Review Paper** |
| Feb 22 | 5 | Surveying primary literature<br>**294: Review article summary**<br>**294: Lab rotation feedback** | Literature search 1<br>**694: Lab rotations self reflection** |
| Feb 29 | 6 | Stating a testable hypothesis<br>**294: Annotated Bibliography (3 articles)** | Literature search 2 |
| Mar 7 | 7 | Experimental design<br>**294: updated Annotated Bibliography**<br>**294: Literature Review** | Planning experiments 1<br>**694: brainstorming notes (after lab)** |
| Mar 14-18 | | Spring Break | |
| Mar 21 | 8 | Writing procedures<br>**694: Bring a procedure example** | Planning experiments 2<br>**694: Lit review feedback** |
| Mar 28 | 9 | Other proposal components<br>**294: Research Project Plans**<br>**294: Notes on funded proposal** | 294: Discussion with instructor<br>**694: Research Project Plan feedback** |
| Apr 4 | 10 | What is science? | Experiments |
| Apr 11 | 11 | Statistical analysis of data | Experiments |
| Apr 18 | 12 | Ethics of scientific research<br>**294: research proposal** | Peer review and proposal revision<br>**294/694: peer review of proposal drafts** |
| Apr 25 | 13 | Science and society<br>**294: Final proposal** | Develop presentations |
| May 2 | 14 | Careers in Science<br>**294: Final presentations** | Practice presentations with mentors<br>**294/694: course evaluations** |
| May 3<br>3:15-5:15 pm | | Final Exam: **CHEM 294 student presentations** | |